SHORTEST PATH IDENTIFICATION USING PSO AND ABC ALGORITHM

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ABSTRACT

Shortest Path problem is one of the basic and important for network optimization problem and it is used for many real applications. In this paper combined algorithm is used for multipath shortest path problem. The proposed method is divided into two steps: (1) we use a Particle Swarm Optimization technique (PSO) to propose an algorithm for finding the expected shortest path. (2) Artificial bee colony (ABC) algorithm is used to find out the larger bandwidth and lesser traffic in the respective selective shortest path from the overall network. Compared to existing works, experimental results show improvement in throughput, average delay, packet delivery ratio, packet loss, throughput and overhead.

KEYWORDS: Network on Chip, Shortest Path, Particle Swarm Optimization Technique, Artificial Bee Colony (ABC) Algorithm

INTRODUCTION

In wireless sensor network, problem of shortest path is one of the important optimization problems. The motive behind the shortest path is to find out the minimum way between the two nodes in a graph or network on chip [B. Zhang, and H. T. Mouftah], [M. J. Liberatore] and [E. Oki and A. Iwaki]. In [E. Dijkstra] proposed a shortest path is implemented by Dijksra, it is one of the technique used to find out the shortest path. Other shortest path algorithms are Bellman-Ford algorithm [R. Bellman], Moore's algorithm [N. Deo et.al] and Dantzig's algorithm [G. B. Dantzig]. Graph consists of nodes and edges, nodes are connected to edges. Every edge has termination with other edges at some nodes [Linkai Bu and Tzi-Dar Chiueh]. In a shortest, the routing message from the source to destination is discarded; it is considered that the message from the source is not forwarded to the destination in a shortest way. Shortest path is one of the optimal techniques without any delay in the intermediate node; it gives the information from the source to destination node. Information discarded is also due to some of the problem such as traffic or some physical link failure [Jie wu]. Shortest path is used in much application such as computer science, communication, industrial engineering and management science. The common problem in shortest path is time delay between the source and destination it is based on the time window, telephone traffic, routing within transportation network, robot path planning, and bandwidth of the routing link. Artificial neural network (ANN) is used for solving the shortest path problem [M. K. Ali, F. Kamoun], [J. Wang] and [F. Araujo et.al]. But it has some limitation such as complexity in hardware, number of nodes and stability is decreased. After the ANN, Genetic algorithm (GA) is used for shortest path [M. Munemoto et.al], [J. Inagaki], [C. W. Ahn, R. S. Ramakrishna] and [M. Gen et.al], here computational cost is high. In [Fábio Hernandes et.al] shortest problem on network is implemented with fuzzy parameter. Oriented Spanning tree based genetic algorithm is used for shortest path. Here Multi-criteria shortest path is considered. ACO is also one of the optimization technique, in [Andrei Lissovoi and Carsten Wit]

one of the simple algorithm of ACO is λ-MMAS is used for shortest path problem. Here the shortest path problem is studied by rigorous runtime analyses. In this paper, shortest path is finding out by PSO algorithm with less computation cost.

METHODOLOGY

Routing in Noc

Network on Chip is implemented to prevent the complicated on chip communication challenges [W. Dally and B. Towles], [L. Benini and D. Bertozzi] and [S. Kumar et.al]. NoC architecture is inspired by many fields such as Internet, communication [K. Kobayashi et.al], and wireless networks [Y. Ishii], with interprocessor communication supported by a packet-switched and circuit-switched network [W. Dally and B. Towles], [L. Benini and D. Bertozzi]. The basic idea behind the NoC is to transmit the message across the chip. NoC architecture prevents the problem taken by long wired bus architecture. The overall performance of NoC architecture is based on the routing strategies.
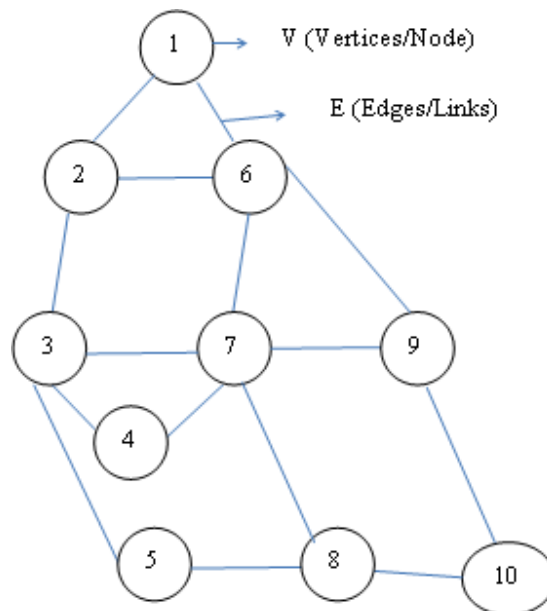
Figure 1: Sample Network Topology

Figure 1 gives the sample network topology. The network consists of set of nodes connected together. Network is defined as $(V,$ where V defines the vertices of the network and E denotes the edges or links connection between two nodes.

Shortest Path Communication

In this paper, Particle Swarm Optimization technique is used to find out the shortest path from the multiple paths. This algorithm is one of the very efficient searching algorithms. PSO is developed by Kennedy and Eberhart in 1995 [W. Dally and B. Towles]. First in this algorithm initialize the random particle with n-dimensional search space. Each random particle is representing the candidate solution. In this each particle have random location and velocity for dimensional space. In this algorithm, position of the particle at every iteration is defined as $x_i(t) = [x_{i1}, x_{i2}, \ldots]$, where i denotes the particle position and t defines the iteration. Each particle moves through the dimensional space with velocity $v_i(t) = [v_{i1}, v_{i2}, \ldots]$ is computed by below equation.

$$v_{ij}(t) = wv_{ij}(t) + c_1\eta_1[y_{ij}(t) - x_{ij}(t)] + c_2\eta_2[\hat{y}_{ij}(t) - x_{ij} \qquad (1)$$

In the above equation, dimension of the search space is denoted by j, $j \in [1,2,\cdots]$. Acceleration coefficient is defined by parameter   and   , random numbers are indicated as   and   . Particle personal best position is denoted by y_i and it is named as p_i. global best position of the swarm iteration t is denoted by $\hat{y}$ and it is named as g_i.

The function behind the two best positions is given as below:

- If the best position is found by the particle until iteration during the search process called as p_i.

- If the swarm find out the best position until the iteration t, is called as g_i.

  - In this algorithm velocity have minimum and maximum range such as $[v_{min}, v_r$.

  - If once the velocity is updated, particle new position i is computed for iteration t+1 by using below equation:

  - $x_i(t + 1) = x_i(t) + v_i(t +$ (1)

  - $w(t) = w_{max} - t \times \dfrac{(w_{max} - w_1}{t_{max}}$ \qquad (2)

- In the above equation, w_i and w denotes the initial and final inertia weight, maximum number of iteration is denoted by t. base on this equation parameter w reduces as per the iteration increases.

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Pseudo code for PSO algorithm
   Step 1: initialize the swarm s in dimensional
space
   Step 2: while maximum number of iteration is
not reached do
   Step 3: for all particle I of the swarm do
   Step 4: particle fitness is calculated
   Step 5: first pbest is set
   Step 6: end for
   Step 7: gbest of the swarm
   Step 8: for all particle i of the swarm do
   Step 9: velocity and position is updated.
   Step 10: end for
   Step 11: end while
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Shortest path in the link is finding out by following steps:

Step 1: Swarm search space is initialized.

Step 2: find out the position of each particle.

Step 3: Set the maximum iteration and maximum particle count from minimum value in loop condition.

Step 5: Calculate the fitness of the particle.

Step 6: Based on weight with the links finds the shortest path, it is given by p_{best} and g_{best}

Step 7: Find out which one gives the shortest path for the node.

This algorithm finds out the shortest path in the multiple paths. Multiple paths consists of different way, in this the information sends from the source to destination. So in this multiple path shortest path is given by PSO algorithm.

Artificial Bee Colony (ABC) Algorithm

The shortest path is given by PSO algorithm, even though some traffic and low bandwidth is present in the given shortest path. So, in this paper ABC algorithm is used to find out in which path consists of heavy traffic and low bandwidth and given low priority to that path and select the traffic and large bandwidth path for message transmission from source to destination in NoC. Basically, artificial intelligence methods are used to solve optimization problems. These methods are based on the collective behavior of flocks of birds, schools of fish, colonies of ants, swarms of bees, and termites. Honey bee behavior is the inspiration for ABC algorithm [A. Banharnsakun et.al]. This algorithm consists of three groups of bees such as employed bees, onlooker and scouts. The scout and onlooker bees are equally partitioned by colony in the initiation level.

2.3.1 ABC Procedure for Routing Optimization

The position of a food source represents the possible solution of problem and quality of the solution is calculated by the fitness function it is given by the nectar amount of food source. In total population, number of solution is equal to number of employee bees and each employee bee is associated to one food source. First, initial solution is considered by randomly distributed initial population. Food source is selected by onlooker bee and it is based on the food source probability value it is defined as:

$$p_i = \frac{f_{it}}{\sum_{n=1}^{SN}}$$ (3)

Fitness value for food solution is indicated by f_{it}, number of food source is represented by SN and it is equal to the number of employed bees.

$$v_{ij} = x_{ij} + \varphi_{ij}(x_{ij} -)$$ (4)

The above equation is used to create the candidate food position from the old one . Parameter k and j are randomly selected variables. These two parameter is not equal to each other and the variable indicate a random number between $[-$. Finally each candidate food position is compared with old one and it is evaluated by artificial bee. If new position has better quality, better bandwidth and there is no traffic then the old position is replaced by the new candidate position, otherwise the old one is retained. However the position cannot be performed well such as it has higher traffic and lower bandwidth in selected shortest path, in this situation the food source is assumed as abandoned. In this condition the corresponding bee becomes scout. New food source is situated in the abandoned position it is founded by scout.

Let us assume, is abandoned source, new food source is discovered by scout is given below:

$$x_{ij} = m_{ij} + rand(0,1)(n_j -)$$ (5)

In the above equation m and n denotes lower and upper bands of the abandoned source.
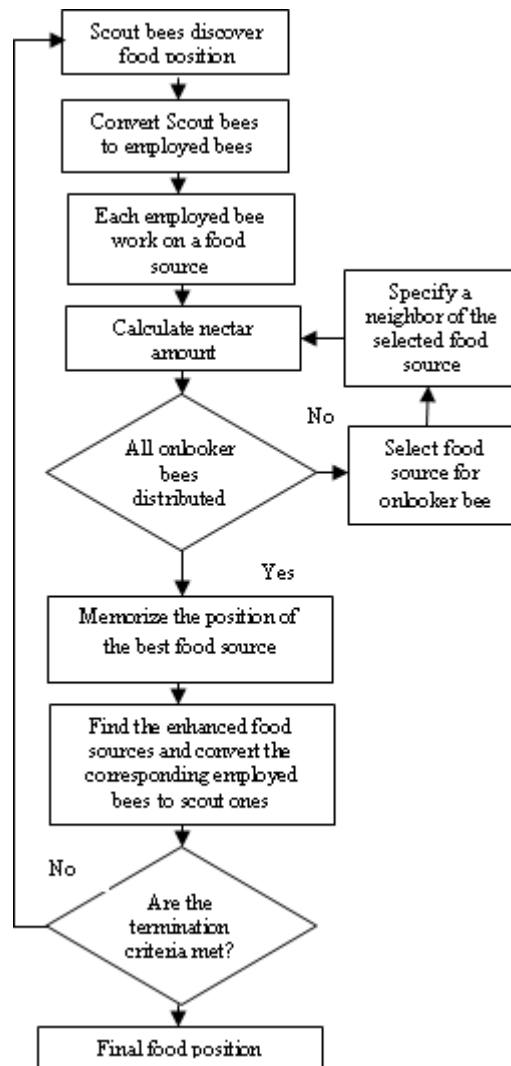
Figure 2: Flow Chart for ABC Algorithm

DISCUSSIONS

In this paper, example is presented to show the proposed work in details with consists of 5 nodes and 7 links. The example is shown in below figure.
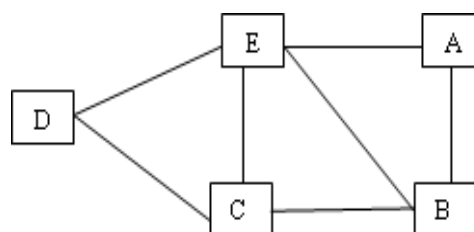

Figure 3: Simple Network Topology

There are five paths is present between each node pair, number of employed bee is equal to number of food source. In ABC algorithm, three steps are available for each cycle.

- The nector amount is calculated.

- After the sharing of information by employed bee, food source is selected by onlooker bee.

- Finally scout bee is used for sending the possible food sources.

In the initial step, food source is selected randomly by bee and nector amount for this food position is determined. For this problem two parameters are needed for optimization.

Let us assume 10 number of food source, then ABC algorithm generates randomly 10*2 matrixes for this connection in first cycle, employee bees process are happened that 10 employee bees are sent onto the food source and their nector amount is calculated based on the fitness of the corresponding food source. Then the employee bee calculates the fitness of the new food source position. If the new one is better than the old or previous food position, then the employee bee forgets the old one remember the new one in their memory.

After employee bee process, onlooker bee process is started. Onlooker bee gets the nector amount of the food position from employee bee. The function of this onlooker bee is chosen the food source based on the probability of the nector amount shared from employee bee derived from equation. (3).

After the onlooker bee, scout bee is used for searching purpose. The food source of which the nectar is abandoned by the bees is replaced with a new food source by the scouts.

EXPERIMENTAL RESULTS

In order to evaluate the performance of proposed shortest path methods, the following metrics were considered:

- Average Delay

- Packet loss

- PDR

- Throughput

- Overhead

Average Delay

It is the average time from the beginning of a packet transmission at a source node until packet delivery to a destination.
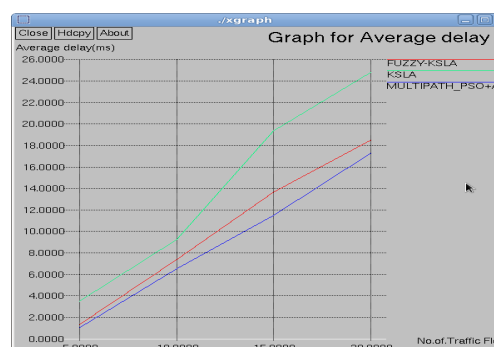

Figure 4: Comparison of Average Delay

Figure 4 illustrates the graph for average delay; it gives the comparison of Fuzzy KSLA, KSLA and proposed multipath PSO with ABC method. It is observed that the proposed method provides lesser shortest distance than the Fuzzy KSLA and KSLA.

Packet Loss

It is the difference between the total numbers of packets send by source and received by sink.
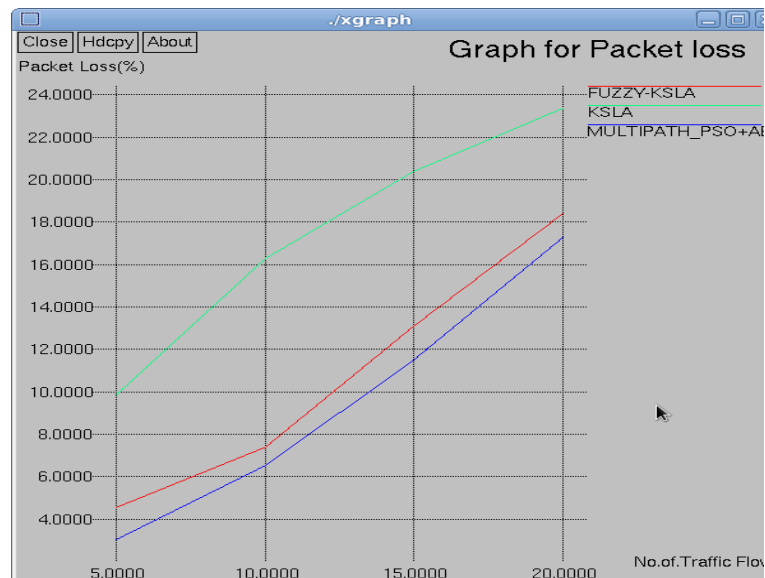

Figure 5: Comparison Graph for Packet Loss

Overall from the figure, proposed PSO with ABC provides lesser packet loss than other two approaches.

Overhead

It is the ratio of the total number of routing packets sent and the total number of packets sent.
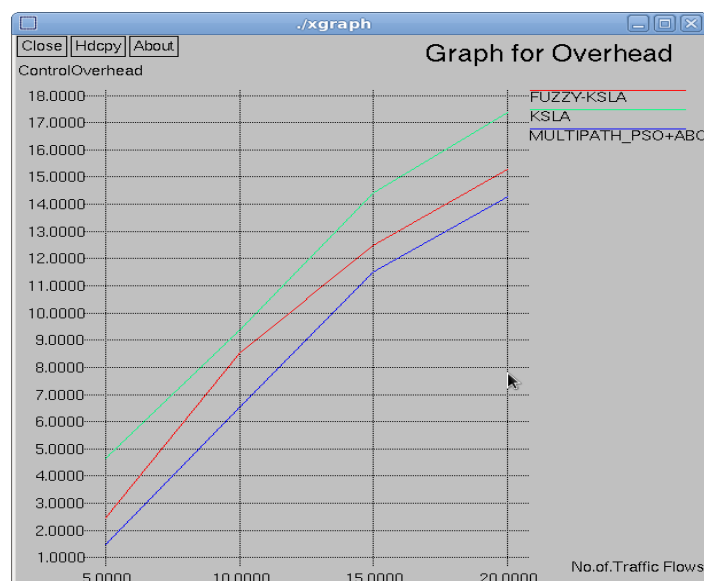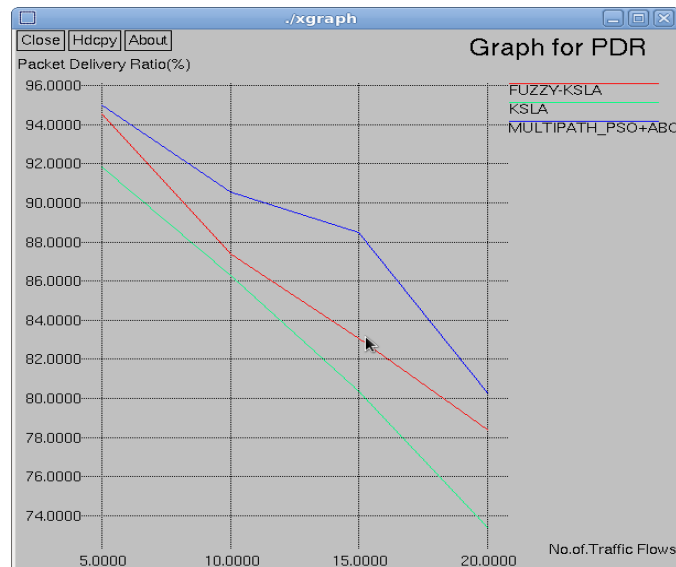

Figure 6: Comparison Graph for Overhead

From the Figure 6 observed that least overhead is obtained by proposed multipath PSO with ABC compared to other two approaches.

Packet Delivery Ratio

It is defined as the ratio between the actual packets delivered to the total packet
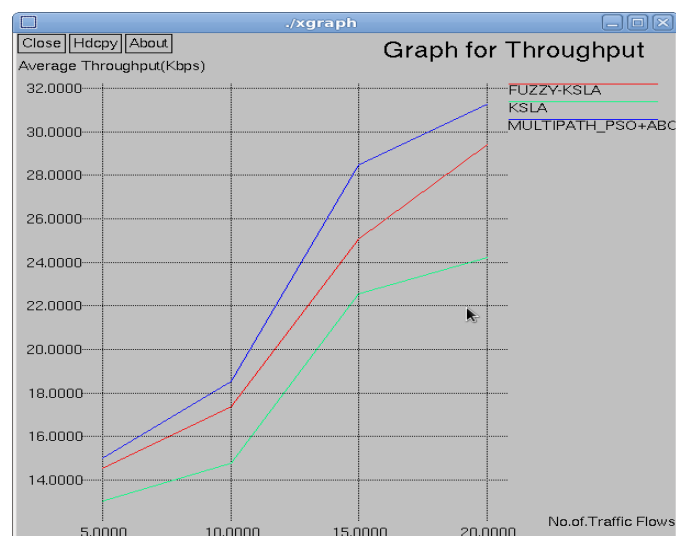

Figure 7: Comparison Graph for Packet Delivery Ratio

The figure 7 illustrates the comparison of packet delivery ration for fuzzy KSLA, KSLA and multipath PSO with ABC.

Throughput

With the given time interval the number of packets are received by the destination is defined by throughput measure.

Figure 8: Comparison Graph for Throughput

Overall comparison of throughput proposed multipath PSO with ABC provide lowest throughput than other two approaches.

CONCLUSIONS

This paper presents the investigations on the application of particle swarm optimization (PSO) with artificial bee colony (ABC) algorithm. The performance of the proposed approach has been compared with two recent works using Fuzzy KSLA search and KSLA search to solve shortest path routing problems. Moreover, in addition to obtaining the shortest path, the proposed algorithm of multipath PSO with ABC obtained the good success rates with performance metrics are evaluated in results.

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